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The abudance and food consumption of dragonfly (Odonata) imagos on the Kis-Balaton, Hugary

By

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Abstract. Dragonfly larvae feed in aquatic habitats. Their imagos live on land. They remove a lot of eutrophicating nutrients with their body from the water. They have an important role in the nutrient cycle both in the water and on land. The abundance of dragonfly imagos was estimated in characteristic plant communities to know their role in the nutrient cycle in smaller details. The daily consumption of common species was measured. According to our estimates, during a summer day dragonfly imagos consume a quantity of insects equal the about 2 or 3 times of their gut content. Consequently, the biomass of insects consumed daily by dragonflies in a characteristic helophyte community along the bank of the river Zala is about 1 kg/hectare.

On the basis of the collectings carried out in the 1940's the Odonata fauna of the Kis-Balaton can be regarded as wellknown. The dragonfly material of the Hungarian Museum of Natural History (Budapest) was taxonomically evaluated together with specimens originating from the territory of the Kis-Balaton. Since that time the material mentioned above has been completed with specimens collected in further collectings (ÚJHELYI, 1955 a). The material kept in the Museum of Natural History contains 26 dragonfly species from the territory of the Kis-Balaton. Later the distribution map of the dragonflies of Hungary was prepared. The computerization of the faunistical data is going on now (DÉVAI & al., 1976). The Kis-Balaton area has become a favourite collecting site of Hungarian zoologists for a long time, but faunistical investigations have been carried out systematically only by our team and by a research worker from the Museum of Natural History.

The collected species were classified according to their zoogeographical and ecological characters. Our aim is to know the quantitative and qualitative characters of this fauna.

Furthermore, we wanted to reveal the metabolism of dragonfly imagos from a quantitative point of view. It is well-known that all the insects whose imagos leave the water take N and P with them in their bodies. These elements cause eutrophication in significant quantities. Considering that dragonflies have relatively large bodies, the quantity of the substances taken out from the water is also significant. A large part of the substances taken out by these insects does not return to the water because dragonfly imagos are terrestrial animals. It was also taken consideration that among insects, dragonflies represent a group of top predators and therefore they are parts of both aquatic and terrestrial foodchains.

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Materials and methods

Besides the traditional mapping with a butterfly net — which is generally used for qualitative collecting — we also had to use a line transect method because of the lack of available literature. The line transect method proved to be adequate in the estimation of the populations of other groups of animals earlier (SOUTHWOOD, 1978).

In different characteristic plant-associations we walked for a defined distance and the number of dragonflies flying up on the right side as well as on the left side within 2 meters was counted. The observed insects were determined as accurately as possible. Our visual determinations were completed with collectings carried out later by grass-, viz. butterfly-nets to justify control our previous determinations. All the bigger and faster-flying species crossing the studied stripe were observed and listed as it is usually done in ornithological field observations. The full size of the study areas in different plant-associations varied between 50 and 200 m^2 — according to the local situations and the extension of the given population. According to our observations the size of the study-area mentioned above seems to be sufficient for obtaining reliable estimations despite the fact that the dispersion of dragonfly species is unequal.

Feeding experiments with dragonflies had not been carried out earlier so we had to work out a new method. The imagos caught by hand were fed with small insects coloured with carmine. After feeding, dragonflies were kept for a given time in big plastic sacks (d=70 cm, m=100 cm), stretching out between leaf-covered tree braches. Later, but still on the field, dragonflies were dissected and the distance of the coloured food had moved forward in their gut was recorded. This experiment was done with the abundant species in different seasons. Considering the fact that the guts of the dragonflies we caught and dissected as controls were generally full of food we can suppose that these insects are feeding continuously during their daily cycle. This enables us to estimate the quantity of food consumed daily if we know the volume of dragonflies gut and the speed with which the consumed food moves forward.

Description of the study sites

The Kis-Balaton, situated at the western end of Lake Balaton, was still a huge swampy area in the last century. By the beginning of the eighties only small fragments remained, which are now protected. They form a nature protection area. It conserves a very interesting fauna. During the last decade, partly for reconstruction, partly for the improvement of the water quality of the Zala River, a big established, whose flora and fauna is now forming and changing rapidly. The dragonflies of the nature protection area and that of the reservoir were studied with the aim of a systematic comparison.

Results and conclusions

35 dragonfly-species (Tab. 1) were recorded within the territory of the Kis-Balaton. This number is more than half of all the dragonflies known from Hungary. The majority of the species found here seemed to be Mediterranean fauna elements (51%), but Siberian elements were also present in significant proportions.

From an ecological point of view the majority of the dragonflies is common and characteristic for standing waters. The comparison of the dragonflies from the nature protection area and the reservoir can be seen in Tab.1. In the variable plant-associations of the nearly undisturbed nature protection area we found dragonflies representing a significantly greater number of species than on the territory of the reservoir every

Table 1. List of the dragonfly species collected from the territory of Kis-Balaton

Species	Fauna element type	Common	Occurring	
			Natural Prot. Area	Reservoir
Platycnemis pennipes	Ponto-Caspian	+	+	—
Coenagrion puella	Ponto-Caspian	+	+	+
Coenagrion pulchellum	Ponto-Caspian	+	+	+
Erythromma najas	Siberian	—	+	—
Erythromma viridulum	Ponto-Mediterranean	+	+	—
Ischnura elegans pontica	Ponto-Caspian	+	+	+
Sympecma fusca	Holomediterranean	+	+	+
Lestes barbarus	Holomediterranean	—	+	—
Lestes dryas	Siberian	+	+	—
Lestes sponsa	Siberian	—	+	—
Lester virens vestalis	Ponto-Mediterranean	—	+	—
Agrion splendens	Ponto-Mediterranean	—	+	—
Brachytron pratense	Ponto-Caspian	—	+	—
Aeschna affinis	Holomediterranean	—	+	—
Aeschna cyanea	Holomediterranean	—	+	—
Aeschna mixta	Holomediterranean	+	+	+
Aeschna viridis	W.-Siberian	—	+	—
Anaciaeschna isosceles	Atlanto-Mediterr.	+	+	+
Anax imperator	Holomediterranean	—	+	—
Gomphus vulgatissimus	Siberian	—	+	—
Cordulia aeneaturfosa	W.-Siberian	—	+	—
Somatochlora aenea	W.-Siberian	—	+	—
Libellula depressa	Ponto-Mediterranean	+	+	—
Libellula fulva	Ponto-Mediterranean	—	+	—
Libellula quadrimaculata	Siberian	+	+	—
Orthetrum cancellatum	Holomediterranean	—	+	+
Orthetrum albistylum	Ponto-Mediterranean	—	+	—
Crocothemis servilia	Holomediterranean	—	+	—
Sympetrum meridionale	Holomediterranean	—	+	—
Sympetrum sanguineum	Holomediterranean	+	+	—
Sympetrum flaveolum	Siberian	—	+	—
Sympetrum striolatum	Holomediterranean	—	+	—
Sympetrum vulgatum	Siberian	+	+	+
Leucorrhinia pectoralis	W.-Siberian	—	+	—
Leucorrhinis caudalis	W.-Siberian	+	+	—

year, where we recorded the presence of 8 species in large numbers. These species were the following: *Sympecma fusca, Coenagrion puella, C. pulchellum, Ischnura elegans. Aeschna mixta, Anasciaeschna isosceles, Orthetrum cancellatum* and *Sympetrum vulgatum.*

During the second phase of the establishment of the reservoir, the construction destroyed a major part of the vegetation of *Glyceria maxima,* which covered the shore. This resulted in a significant decrease in the number of species as well as in the numbers of individuals in the territory of the nature protection area in 1988—1989. According to our estimates for 1986—1987 in the territory of the nature protection area dragonflies were flying in great masses mainly over the dike of the Zala River, which crosses the area, more specifically over the *Glyceria maxima*-vegetation along the bank which covers the slopes of the dike (Tab. 2—4), but they could be found in great numbers on the cut meadow nearby (Tab. 5) and along the edge of the woods (Tab. 6). They formed groups at sunny areas covered by low vegetation. Dragonflies are very rarely found in reed-beds and in different woods. They very sensitively respond to changes in temperature and light as well as to wind effects.

Table 2. Abundance of the dragonflies flying over the dike of the Zala River (Data are given pro an area of 100 m^2)

Month/day/year	06/09/86	07/31/86	09/18/86	04/30/87	06/26/87	09/03/87	09/22/87	10/04/87
Coenagrion pulchellum	—	—	—	—	8.0	—	—	—
Platycnemis pennipes	—	—	—	—	32.0	—	—	—
Lestes virens	—	—	—	0.3	—	1.6	0.1	—
Lestes dryas								
Ischmura elegans	—	—	0.1	—	—	—	—	—
Agrionidae	—	14.5	—	—	—	—	—	—
Sympetrum sp.	—	0.3	0.2	—	12.0	5.0	0.3	0.2
Aeschna mixta	—	—	0.2	—	—	—	0.1	—
Anisoptera	9.8	0.3	0.4	—	12.0	5.0	0.4	0.2
Zygoptera	327.0	14.5	0.1	0.3	96.0	1.6	0.1	—
Sum.:	336.8	29.6	1.0	0.6	160.0	13.2	1.0	0.4

Table 3. Abundance of the dragonflies flying over Glyceria maxima vegetation covering the slopes of the dike along the Zala River

Month/day/year	06/09/86	07/31/86	04/30/87	06/26/87	09/03/87	09/22/87
Coenagrion pulchellum	—	10.0	—	16.0	—	—
Sympecma fusca	—	—	1.5	—	—	—
Lestes sp.	—	—	0.5	—	0.4	—
Libellula depressa	—	—	—	4.0	—	—
Sympetrum sp.	—	9.0	—	—	4.2	1.0
Aeschnidae	—	2.0	—	4.0	—	0.3
Zygoptera	245.0	10.0	2.0	128.0	0.4	1.0
Anisoptera	8.0	11.0	—	8.0	4.2	0.6
Sum.:	253.0	42.0	4.0	160.0	9.2	2.9

Table 4. Abundance of dragonflies above the surface of the Zala River

Month/day/year	07/31/86	04/30/87	09/03/87
Ischnura elegans	—	—	0.8
Lestes sp.	—	—	4.5
Agrion splendens	0.2	—	0.8
Agrionidae	14.0	—	13.5
Sympetrum sp.	—	—	1.4
Leucorrhinia pectoralis	—	0.01	—
Aeschna mixta	1.3	—	—
Libellula depressa	1.6	—	—
Sum.:	17.1	0.01	21.0

Table 5. Abundance of the dragonflies flying on the nature protection area over a cut, sunny meadow

Month/day/year	06/09/86	07/31/86	04/30/87	06/26/87	09/03/87
Platycnemis pennipes	—	—	—	1.0	8.0
Sympecma fusca	—	—	3.3	—	—
Anaciaeschna isosceles	—	—	—	2.0	—
Sympetrum sp.	—	5.0	—	9.0	2.0
Zygoptera	10.2	—	3.3	1.0	8.0
Anisoptera	5.0	—	—	11.0	2.0
Sum.:	15.2	5.0	6.6	24.0	20.0

Table 6. Abundance of dragonflies flying on the territory of the nature protection area on the edge of a wood

Month/day/year	07/31/86	06/26/87	09/03/87
Aeschnidae	2.0	—	—
Sympetrum sp.	4.0	7.0	8.0
Anisoptera	6.0	7.0	8.0
Sum.:	12.0	14.0	16.0

In our feeding experiments the consumed food passed the alimentary canal of the animals in 3 to 15 hours (Tab. 7) depending on the species and the actual temperature. In this respect differences between the different species and sexes were not significant. The absolute quantity of the food consumed was correlated with the size of the animal. To estimate the quantity of food consumed by dragonflies first we had to calculate the volume of the alimentary canal of the animals. This was done for the 12 commonest dragonfly species of the Kis-Balaton. For every species, the mean-value of 10 specimens was given.

Considering the fact that the alimentary canal of our animals is cylindrical, its volume could be calculated after the lenght of the gut and its diameter (Tab. 8) had been determined. Because the food that dragonfly imagos consume, gets into the alimentary canal in a finely chewed form, the gut content could not be analysed. In spite of this fact, we were able to estimate — according to our original aim — the food of the dragonflies as consumed biomass.

Table 7. The speed of food moving forward ind the gut of dragonflies

Date	06/9—10/86			07/31/86			09/18—19/86			06/26/87			09/3—4/87		
Species	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.
Platycnemis pennipes	♀	4h 15m	6th s.	♂	4h	E.				♂	3h 30m	5th s.			
	♀	5h	6th s.	♂	4h 30m	E.									
	♀	5h	6th s.	♂	2h 30m	4th s.									
				♂	2h 30m	5th s.									
Coenagrion puella	♂	2h	E.												
Coenagrion pulchellum	♀	4h 20m	E.												
	♂	4h 40m.	E.												
	♂	4h 40m.	E.												
	♂	3h 30m	6th s.												
Ischnura elegans				♀	2h 50m	6th s.	♂	15h	8th s.				♂	3h	8th s.
							♀	15h	E.				♂	3h	E.
							♂	15h	7th s.						
Lestes dryas													♂	3h 30m	7th s.
													♂	3h	6th s.
													♂	4h	7th s.
													♀	10h	E.
													♀	3h	4th s.
													♂	3h	7th s.
													♀	2h 45m	5th s.
													♂	2h 45m	5th s.
Anaciaeschna isosceles	♀	3h	6th s.												
Agrion splendens										♀	3h 20m	E.			
Cordulia aenea	♀	3h	E.							♀	3h 30m	3rd s.			
Libellula quadrimaculata										♂	3h 20m	8th s.			
	♀	4h 30m	E.							♂	3h	7th s.			
Orthetrum cancellatum	♀	3h	E.							♀	3h 20m	2nd s.			
Sympetrum sanguineum							♂	3h	4th s.	♂	4h	6th s.	♂	3h	6th s.
							♂	3h 30m	5th s.	♂	4h	5th s.	♂	2h 30m	7th s.
							♂	3h	4th s.	♀	3h 45m	5th s.	♀	14h	E.
										♀	3h 30m	4th s.	♂	3h	6th s.
										♂	3h 30m	7th s.	♀	3h	4th s.
										♀	3h 30m	6th s.	♀	3h	7th s.
										♀	3h 30m	5th s.	♂	3h	8th s.
Aeschna mixta							♀	4h	3rd s.	♀	3h	E.			
							♂	3h	2nd s.						

I.: Sex. II.: The amount of time the experiment took in hours and minutes. III.: How forward the food moved in the alimentary canal: E means entirely, s is an abbreviation of segment.

Table 8. Length and volume of the gut of different dragonfly species

Species	Length of the gut (mm)	Volume of the gut (mm^3)
Platycnemis pennipes	36.2	8.61
Coenagrion puella	32.9	6.80
Coenagrion pulchellum	33.5	8.08
Ischnura elegans	31.5	7.08
Lestes dryas	37.5	11.14
Agrion splendens	46.2	17.68
Aeschna mixta	47.0	71.60
Anaciaeschna isosceles	54.0	179.96
Cordulia aenea	44.0	114.73
Libellula quadrimaculata	38.0	68.58
Orthetrum cancellatum	40.7	64.60
Sympetrum sanguineum	27.2	23.93

There are great differences in the capacity of the guts of different species it can be seen from Tab. 8. To make the survey easier in this respect, we distinguished 3 categories.

The volume of the gut of the smallest species is about 10 mm^3 or smaller while being filled with food. The gut-volume of middle-sized species is about 20 mm^3, whereas that of the biggest species is about 50 mm^3. For the estimation of food consumption, we chose a day in June suitable for active flying.

According to our observations the animals begin to feed at 8 o'clock (summer time) and their foraging activity lasts till sunset. Their gut content changes at least three times day if the temperature is normal around the average in summer.

The daily food consumption of a *Coenagrion pulchellum* individual is about 24 mm^3. This number for a *Sympetrum sanguineum* is 71.8 mm^3, whereas for an *Anasciaeschna isosceles* it is about 540 mm^3. If, for the sake of simplicity, the specific gravity of the consumed food is considered as 1 g/mm^3, 1 mm^3 volume is the equivalent fo 1 g biomass.

On the basis of the averages of our estimates from the years of 1986 and 1987 we can state that, for example, the dragonfly population inhabiting an area of 1 ha catched flying insects in a quantity of 1.16 kg every day. Contrary to these data in the same season in 1988, we could not find any dragonfly there. According to our estimates made in July, dragonflies consumed insects in a quantity less than 0.14 kg per ha.

Our research proved that the dragonflies of the Kis-Balaton area — just like the dragonflies of similar areas — need to be evaluated as an important element in the material cycles.

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